

Sheet (3)

1. It's 1999. Alice and Bob are 4 hops apart on a datagram packet-switched network where each link is 100 miles long. Per-node processing delay is $5\mu\text{s}$. Packets are 1500 bytes long. All links have a transmission rate of 56kbit/s (original speed of Internet backbone links in the 90s). The speed of light in the wire is approximately 125,000 miles/s. If Bob sends a 10-packet message to Alice, how long will it take Alice to receive the message up to the last bit (measured from the time Bob starts sending)?

2. Alice and Bob 12 years later, all are the same, except that link transmission rate now is 1 Gbps. How long will it take Alice to receive the message up to the last bit (measured from the time Bob starts sending)?

3. Repeat Q1 and Q2, assuming that the network uses circuit switching instead of datagram packet switching. Assume the call setup packet transmission time is negligible. Bob's message is the same length as before.

4. A message of 6000 bytes is transferred over a communication network with 60 km hop distance and 3 intermediate nodes. The data rate on all links is 96kbps. The propagation speed on any link is $250\text{m}/\mu\text{s}$. The packet size is 250 bits and 50 bits as a header. The set-up time is 0.2 sec. The processing at each node time is 0.025 sec, while the average queuing delay at each node is 0.15sec. Compare between the end-to-end delay time for circuit and datagram switching techniques.

5. (report) It is required to transfer a message with size 80 Kbytes on a communication network with 3 nodes, from the user to the server. The data rate for all links is 2 Mbps. The packet size is 1000 bits and 100 bits as a header. The setup time is 0.12 sec, with processing time at each node is 0.08 sec at each node, while the average queuing delay at each node is 0.2 sec. The propagation speed over a link is $300\text{ m}/\mu\text{sec}$, where the hop distance is 60 km. Calculate the end-to-end delay time for the following cases:

□ Circuit switching network

□ Datagram packet switching

□ Virtual circuit packet switching network with ack. $P_{\min} = 70$ bits.